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IMPROVING THE QUALITY OF NAVY TRAINING: THE ROLE OF R&D IN SUPPORT OF INSTRUCTIONAL SYSTEMS DESIGN

NAVY PERSONNEL RESEARCH AND DEVELOPMENT CENTER SAN DIEGO, CALIFORNIA

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In this paper, background developments leading to the adoption of the Instructional Systems Development (ISD) model are described briefly. During the 1960s, a systems analysis approach to training by a team of experts evolved into the ISD approach, which assumed that the methods used by experts could be described completely enough to allow nonexperts to carry out training development. Recent studies evaluating ISD implementation suggest that this goal has not been reached. While ISD as a general curriculum development procedure is adequate, it needs considerable detailed refinement.

Nonetheless, a return to an older systems analysis approach seems unlikely because experts are in short supply, and demands for training programs are high. Therefore, we recommend a research and development approach to refining the ISD process, simplifying it, and supporting its implementaiton so that it can produce more effective and job-relevant training for the military services.

FOREWORD

This report was written at the request of the Chief of Naval Operations (OP-115) as an article summarizing the state-of-the-art in procedures for training development and the role of NAVPERSRANDCEN research and development in assisting with problems encountered. It is intended to provide manpower, personnel, and training managers with a general overview of the background of modern approaches to training development, point out certain problems existing in the procedures themselves and in managing their implementation, describe some modest attempts to improve implementation in the future, and make recommendations for improvement.

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SUMMARY

Problem

The Navy needs better training not only because fleet readiness depends on it, but also because increasing technological complexity demands it. Fleet readiness depends upon personnel readiness, which, in turn, is influenced by selection, training, job experience, motivation, leadership, and other factors. To achieve individual readiness--and, in the long run, improve unit and fleet readiness--design technologies must be developed and applied in all of these areas. In training, a design technology--Instructional Systems Design (ISD)--has been developed and adopted. Although ISD is an exciting prospect for improving the quality of Navy training programs and the management of Navy training development, there are problems in its management and implementation and in the adequacy of ISD methods and procedures. Because of this, ISD has not yet achieved its full potential for improving Navy training.

Objective

The purpose of this report is to review the background of ISD, identify problems in the ISD process and in its management and implementation, describe some research and development efforts aimed at solving these problems, and recommend additional research needed.

Approach

Developments leading to adopting the ISD model and systematic studies evaluating the successes and problems of ISD implementation were extensively reviewed. From these reviews, several research programs were begun that aid in solving certain of the problems enountered.

Findings and Conclusions

The ISD process is a synthesis of the results of nearly 40 years of research on instructional development and over 100 previous publications concerning what to do in instructional development. The review found widespread agreement that the ISD process is a good description of what has to be done in the process of analyzing, designing, developing, and managing instruction.

The ISD methods were originally developed to remind instructional development experts about steps needed to be accomplished to produce quality instruction. Recently, though, the intent of ISD methods has shifted. ISD manuals are now intended to help content specialists (who are relatively inexperienced in instructional design and development) build instruction. However, ISD methods do not achieve this intent, because, while they contain "what to do" information, they do not provide information of "how to do it."

This lack of detailed procedural guidance leads to two difficulties in implementing ISD: instructional engineering problems and management problems. Studies have revealed that ISD methods are not implemented well by the untrained, inexperienced personnel available. This leads, in turn, to problems in managing their ISD activity. These problems result in the development of instruction imperfectly matched to Navy jobs and increased costs for evaluation and revision of initially poor instruction.

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A number of policy or management changes to alleviate these problems were considered, including (1) substitution of some other training development methods in place of ISD, (2) substantial training for ISD practitioners to compensate for ISD inadequacies, and (3) contracting for the development of Navy training programs. All these alternatives were rejected as being impractical, too expensive, or as simply cosmetic. Instead, it was decided that the best policy to follow is to improve the ISD methods and their implementation through a systematic research and development program. Several recent R&D efforts were summarized, including the instructional quality inventory (IQI), which provides quality assurance methods for the ISD, the development of procedures for building more instructionally relevant tests in technical training, and the initial development of computer-based systems to assist in managing and conducting ISD. Computer-based aids to ISD, in particular, provide the best hope of improving the efficiency and effectiveness of the ISD process and are essential as more training is delivered via computers.

Recommendations

1. This review identified some deficiencies in the ISD process and its implementation. However, these deficiencies were obtained from only a few studies of ISD and from relatively informal observation. It is essential that the Naval Education and Training Command (NAVEDTRACOM) develop systematic methods for monitoring the implementation of ISD, so that problems can be identified. These problems should then be reviewed periodically to determine their amenability to management, personnel training, or R&D solutions.

2. NAVEDTRACOM should develop a system for monitoring the performance of ISD practitioners and managers and a systematic training and professional development program to improve their performance.

3. NAVEDTRACOM should actively support the development of automated aids to ISD, and should begin planning and programming resources for their eventual implementation and operation.

CONTENTS

INTRODUCTION

Problem

The Navy needs better training not only because fleet readiness depends on it, but also because increasing technological complexity demands it.[1] Fleet readiness depends upon personnel readiness, which, in turn, is influenced by selection, training, job experience, motivation, leadership, and other factors. To achieve individual readiness--and, in the long run, improve unit and fleet readiness--design technologies must be developed and applied in all of these areas. In training, a design technology--Instructional Systems Design (ISD)--has been developed and adopted. Although ISD is an exciting prospect for improving the quality of Navy training programs and the management of Navy training development, there are problems in its management and implementation and in the adequacy of ISD methods and procedures. Because of this, ISD has not yet achieved its full potential for improving Navy training.

Objective

The primary objective of this report is to review selected problems existing in the implementation of ISD methodology and to describe briefly some research and development projects that are underway or needed to aid future implementation of the process.

APPROACH

Developments leading to adopting the ISD model and systematic studies evaluating the successes and problems of ISD implementation were extensively reviewed. From these reviews, several research programs were begun that aid in solving certain of the problems encountered.

REVIEW OF ISD

Navy curriculum design efforts are continually being handicapped by shortages of experts to conduct training program design and development, poor analysis of how to match training to jobs, inadequate prescriptions for deciding how to train, inadequate performance measurements, differences in student skills and motivation, problems in managing Navy schools, and problems in planning the use of computers and simulators in training. It is important to recognize that these problems all stem from fundamental inadequacies in our understanding of how people learn and, therefore, how to teach these people. This leads to inadequacies in training design methods and procedures and to confusions about management of training program design and development. Research and development has led and will lead to improvements in our fundamental understanding of learning and instruction, and in procedural refinements that will lead to improvements in ISD methodology and the formulation of more effective management policies. Careful implementation of existing knowledge and systematic development of information bases for new procedures are needed.

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[1]Chief of Naval Operations Memorandum, Ser 00/100622 of 11 December 1979; subj: CNO objectives for 1980.

The Evolution of ISD

Traditional techniques for developing instructional programs depend very heavily on the expertise of the people doing the development. Until recently, instructional design was an intuitive, artistic process. One problem with this approach is that the intuitions of people about what and how to teach can vary widely. The resulting instruction may then teach irrelevant things or perhaps leave out things that are very important to people's job performance. A second problem is that people's artistry also varies. While one artist may design instruction that communicates very efficiently, another person may produce "instruction" that is barely comprehensible. Thus, instability or variability is built into the traditional instructional development process.

This traditional approach has further problems. Although it is concerned with job relevancy in a general sense, it cannot ensure that training matches job requirements: It might or might not, depending on someone's intuition. The traditional approach also cannot ensure that quality training is developed. Training materials may be developed badly, or materials may be chosen arbitrarily by an instructor or developer. Also, in the traditional philosophy of instruction, the focus is usually on the content that is presented to the trainee, who is expected to learn from the exposure. Instruction is usually "topic oriented" in that it tells about something (e.g., how a radar operates) rather than being "performance-oriented," which tells a student how to operate the radar. The learning is usually not evaluated systematically, and training adequacy is judged in terms of what students say about it. Little attempt is made to identify what difficulty a student is having in learning and to correct it. It is, in essence, a "sink or swim" approach.

During the mid 1950s, training developers recognized the need to guarantee the job relevancy and to monitor systematically inadequacies in learning. They began developing techniques to stabilize and structure the process of training development, to ensure the relevancy of training for people's jobs, and to make training efficient. This approach, adapted from those used in operations research and systems engineering (Churchman, 1968) for the development of weapon systems, led to the development of the ISD process.

ISD procedures evolved from a conviction that the systems analysis approach could simplify the complex task of developing programs of instruction. Systems analysis methods had developed during World War II to help resolve problems in managing the design, production, and evaluation of new weapon systems. The method was applied successfully to numerous problems whose complexity strained any one person's ability to comprehend and accomplish a task. For example, systems analysis has been given credit for the success of the project that put man on the moon (Carter, 1973).

Four main procedures characterize the systems approach:

1. A team of experts is chosen from relevant disciplines to bring as much information and expertise as possible to bear in accomplishing a task.

2. Models or simplified descriptions of subparts of the task are generated to reduce its overall complexity.

3. Unique but systematic solutions to the task are devised.

4. Operational tests are conducted to provide information for later revision and modification (cf., Montemerlo & Tennyson, 1976; Andrews & Goodson, 1980).

As applied to training program development, a group of experts in management, logistics, education/training, systems planning, and other fields generated model procedures to simplify day-to-day tasks. For example, training experts might devise checklists or other outlines to remind them of steps in development that had to be completed and to record such steps when they had been completed. Although such procedures help experts determine what to do next, they do not supplant the intelligence or knowledge needed to carry on the activity (Montemerlo & Tennyson, 1976; Montemerlo, 1979a; Andrews & Goodson, 1980).

During the 1960s, there was a shift away from the systems analysis approach, which relied upon teams of experts, toward development of formal procedures, models, and design decision aids that would enable relatively inexperienced persons to design instruction. These procedures and aids were elaborate forms of the simple models and checklists used by the experts. The prospect of being able to use less experienced people to develop training appealed to managers of military instruction programs because experts were scarce--and still are--and job rotation restricted the buildup of expertise. Over 100 manuals were published telling how to design and develop programs of instruction (e.g., Montemerlo & Tennyson, 1976; Andrews & Goodson, 1980). At various times, these procedures were called "course design procedures," "curriculum engineering," "systems approach to training," and, more recently, "instructional systems development."

Although all these procedures differ in some details, they share a common approach: They analyze jobs to determine training objectives, develop tests to assess whether trainees are progressing toward objectives, gear instruction toward specific learning goals that are tied to the objective, and attempt to detemine how to decide upon the instructional presentations in sufficient detail to minimize the level of experience needed in instructional development and technology.

ISD evolved not as a specific method of teaching but, rather, as a way to determine what trainees really need to know and to ensure that they learn it. With reference to training, ISD's goals are to make training (1) job-relevant (meaning it would ultimately prepare the trainee for his or her function(s) in Navy readiness), and (2) cost-effective and efficient (meaning it would use the most efficient training methods to do the training). With regard to the management of the development of instructional programs, ISD's goals are to (1) make the process more efficient and less haphazard and (2) provide a basis for controlling and evaluating changes.

It is important to understand these training and management goals because people have often confused ISD with particular new teaching techniques. The ISD process is a means for defining training goals, deciding upon the best means of achieving them within resource constraints, and providing evaluation of the program. In theory, any medium of presentation (traditional, self-paced, or computer-managed) could be chosen, depending upon its feasibility. In practice, however, the recommended method is self-pacing because it is more efficient. Self-pacing takes advantage of the fact that people learn at different rates (Branson, Rayner, Cox, Furman, King, & Harnum, 1975). Research has shown that, when self-paced courses are compared with traditional "lock-step" courses, they save considerable time, with students achieving the same or slightly better school performance. For example, in comparisons done in 48 military training courses, achievement in self-paced courses was equal to that of conventional courses in 32 cases, superior in 15 cases, and slightly poorer in only 1 case (Orlansky & String, 1979). There are a number of questions--which research can help answer--about how to implement other types of individualized instruction and whether they are effective for all trainees. Nevertheless, "its use can be expected to continue and expand in the Navy as increased emphasis is placed on training efficiency," according to a 1979 report by the Navy Training Analysis and Evaluation Group (Zajkowski, Heidt, Corey, Merv, & Micheli, 1979), unless it can be shown that traditional methods can be made more efficient through the use of innovative techniques, such as computer-aids for instructors.

ISD Potentials and Problems

History shows that educational innovations in this century go through a peculiar three-stage life cycle (Montemerlo & Tennyson, 1976; Campbell, 1971). In the first stage, advocates of an innovation proclaim its usefulness and its success. In stage two, many people are attracted to the innovation and begin using it. The final stage, however, is one of growing skepticism and criticism of the innovation's adequacy. Because this criticism comes late in the process, it does not help improve the technique but, rather, hastens its abandonment in favor of yet another innovation. The process then begins anew. This may explain why so many training development systems differ only in slight degree from one another (cf., Montemerlo & Tennyson, 1976; Andrews & Goodson, 1980).

Whatever the causes of the cycle--and some theorists believe they are political and social (Milsum, 1968; Montemerlo, 1979b)--the effect is that, when an educational innovation is introduced, its proponents suppress constructive criticism as they nurture and protect their "brain child." The danger is that the ISD model, which has enjoyed its days of advocacy and is now somewhere between phase two of widespread use and phase three of growing skepticism, may share the fate of so many other innovations. Yet any system that replaces ISD will present the same underlying problems. It will be new, unrefined, untested, and probably difficult to manage.

As ISD moves into the criticism phase of its life cycle, it still retains much of its early promise. ISD has made progress in developing techniques to make training more job-relevant. As will be discussed below, however, problems exist in successfully implementing these techniques. The fact that some version of the systems approach model has been adopted by the military services, by industry, and for training development in the civilian sector suggests that the approach is valid (Gropper, 1980). This has happened because systems approaches all include the same general steps that serve as a basis for managing the process, and managers believe that systematic attempts to relate training to job requirements optimize the use of resources better than relatively unsystematic alternatives. The original hope that the procedures of experts could somehow be transmitted by means of manuals to nonexperts, who then carry out training development, does not seem to have been realized (Montemerlo & Tennyson, 1976; Montemerlo, 1979a). This failure stems from a less-than-adequate state of knowledge about human learning and instruction, as well as our inability to provide recipes for training development that untrained people can follow. Therefore, the difficulties encountered in using the ISD process are of two sorts: "instructional engineering" and "management" problems. These problems are discussed in the following paragraphs.

Instructional Engineering Problems

Current ISD procedure manuals are supposedly more complete than earlier ones and more relevant to the development of training for a wide variety of military tasks. Yet, a recent study of the implementation of ISD by 33 groups that developed 57 different courses in all the military services noted that the procedures are still not fully adequate. In this study, Vineberg and Joyner (1980) reported that the job-relevancy issue was often ignored and that previously existing instruction was used as a starting point for course development. Instructional methods were selected not because they were effective and efficient but because they existed. Similarly, tests to measure job-related learning were limited to what could rather than what should be tested. Evaluation of training, according to Vineberg and Joyner, received little emphasis. Feedback systems from operational units concerning job competency of graduates were not well developed. As a result, training programs needed extensive tryouts and revision to make them effective. These findings suggest that, at present, implementation of ISD has not succeeded in attaining the goals of making training job-relevant, efficient, or cost-effective. Evidence for this point has been given in reports of studies of the implementation of systems approaches in training development. Army users, for example, have found guidance incomplete, steps difficult to relate to one another, and job analyses incomplete (Vineberg & Joyner, 1980; Ricketson, Schultz, & Wright, 1970; Hodak, Middleton, & Rankin, 1979; Miller, Swink, & McKenzie, 1978). These findings suggest that those procedures were not implemented well by the untrained, inexperienced personnel available (Montemerlo & Tennyson, 1976).

Our analysis of some Navy courses reveals similar serious deficiencies in training objectives, tests, and course materials (e.g., Wulfeck, Stern, Fredericks, & Ellis, 1979, Stern & Fredericks, in press). Some objectives are not related to performance or knowledge required by the job. Testing does not always measure performance or knowledge required by the objectives. Since instruction often is not geared to the objectives or to the tests, it is confusing and otherwise inadequate. These problems have led, in some cases, to course graduates who are poorly prepared for their jobs, and this has resulted in criticism of ISD by the operational community.

How can it be that these problems result even though the ISD procedures are supposedly more complete than earlier instructional design systems? It appears that these instructional engineering problems are the result of the fact that the ISD procedures specify "what to do" in detail, but not "how to do it," let alone "how to do it well."

It might be useful to underscore this point. For someone who is very knowledgeable and skilled in a particular discipline, a simple reminder that something should be done may be sufficient. This is why simple checklists worked well in the early attempts to use a systems approach to training development. In the development of procedural guidelines, such as those in ISD, the adequacy of the guidance for inexperienced people is the issue. Much more specific "how to do it" information must be provided.

An interesting analogue of this problem was discussed in a recent paper. In a cookbook meant for experienced chefs, a recipe for mayonnaise was found to be six sentences long (plus a list of ingredients). In another book, intended for less experienced cooks, the same recipe was over 13 times longer--some 900 words plus ingredients (Norman, Gentner, & Stevens, 1976). Even with this recipe, a complete novice in the kitchen would have difficulty in completing it successfully.

Are instructional recipes any different? Their adequacy depends on how well the persons doing the work understand what has to be done and all the steps in the process. To show the difficulty with the level of the "recipes" presented in ISD, consider that, out of a 36-page section on developing instruction, only two paragraphs--four sentences--tell how to develop printed training materials, and only one of those sentences offers real guidance: "Write all the student needs to know about each learning objective, but do not write one word more" (Branson et al., 1975, Vol. III, p. 246). Does this provide sufficient guidance for a person inexperienced in techniques of instruction and communication?

In addition to the lack of adequate "how to do it" information, the ISD guidance also contains internal inconsistencies. For example, the ISD process requires that developers (1) specify objectives, (2) develop tests, (3) sequence the objectives into modules, lessons, etc., and (4) develop instruction. The problem is that, although test items can be generated from objectives, they cannot be arranged into modules or lesson tests until the objectives have been sequenced. Therefore, things are out of order. The guidelines say to construct tests before we know what they should contain. Similar inconsistencies can be found throughout the ISD manuals.

Management Problems

These fundamental problems in the adequacy of ISD guidance lead to problems in managing the ISD process. The management problems are further complicated by the fact that managers may not be aware of them. Training development managers often treat the ISD model and procedures as if they were complete and adequate and assume that, if a developer merely follows "the book," instruction will be adequate. There is no recognition of the variability caused by the inadequate procedures. Since the ISD model contains no methods for assuring the quality of materials as they are developed, managers may pay little or no attention to that quality. They do not know how. Rather, they consider the development of training to resemble assembly-line production; thus, the documentation of each step in the process receives more emphasis than the way the inadequate guidelines affect instructional quality. This trivialization of the process can and does result in inadequate programs that need numerous revisions to make them job-relevant. Managers tend to be satisfied when all tasks and forms are completed, even though students may falter (e.g., Montemerlo, 1979a; Vineberg & Joyner, 1980; Hodak, Middleton, & Rankin, 1979; Miller, Swink, & McKenzie, 1978; Middleton, Zajkowski, & Aagard, 1979).

Other more apparent management problems include selecting and training design and development personnel, financing, and other administrative and logistics issues. In the area of selecting and training personnel, the failure to spell out procedures in sufficient detail makes it necessary to find or extensively train people with expertise in training technology. Costs are further driven up as each new instructional program requires (1) new people to learn how to develop it and (2) extensive revisions to validate it. The decision by the Naval Education and Training Command (NAVEDTRACOM) to establish a central organization for developing training programs reflects a tacit recognition that some expertise is needed to compensate for incomplete procedures. The Navy's Instructional Program Development Centers (IPDCs) include civilian technologists who are expected to have or develop and maintain expertise. Most course development and revision will take place outside these centers for some time, however. Building up expertise for regular duty Navy personnel is difficult because of job rotation policies and the lack of appropriate occupational specialties in instructional technology. Navy people do provide subject-matter expertise and, despite their lack of appreciable training in instructional development per se, are given responsibility for developing advanced courses. In this case, the quality of the instruction depends on the intuitions of the personnel. It is not necessarily bad, but its quality is uncertain.

It has recently become clear that the costs of adopting the ISD model are high. However, instructional development costs may always have been high. In the past, these costs were "hidden" in the normal assignment of instructors to Navy schools. To illustrate this point, in the Navy and in the other services, 25 percent of an instructor's workweek is accounted for by categorizing it as course preparation or administrative duties. Therefore, traditionally, course development or preparation costs are high even if only half that time is considered to be course development. In addition, actual course development was and still is done within Navy schools. In a survey completed several years ago, it was found that, for a 2 1/2 year period, four to seven instructors had been assigned to develop objectives for a new course. They were considered part of the school's complement of instructors. The adoption of the IPD approach has made costs more apparent because of the way in which costs are reported, and not necessarily because costs actually have been increased.[2,3]

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[2]Chief of Naval Education and Training Instruction 1550.5 of 11 March 1974; subj: Doctrine for the centralized management and control of ISD.

[3]Chief of Naval Education and Training Support Code N4, Direct Cost Report, of 30 June 1979.

APPROACHES FOR IMPROVING THE ISD MODEL AND IMPLEMENTATION

Policy Considerations

As we have seen, fundamental instructional engineering problems in ISD create problems in the implementation and management of instructional development programs in the Navy. What policy alternatives are available to solve these problems?

One alternative could be to discard the current ISD methodology and "start from scratch." As stated earlier, however, all systematic approaches to instructional development include the same general steps. As a "what-to-do" procedure, ISD is generally adequate, and anything that replaced it would be fundamentally the same.

A second alternative would be to leave ISD as it is but increase the training of ISD practitioners so that they could compensate for the inadequacies in the process. It would be necessary to determine the amount of training developers need and to provide it on a continuing basis for both Navy civilian and military personnel. NAVEDTRACOM's policy of developing courses in IPDCs is intended to build up the level of expertise. These centers, however, concentrate on preliminary technical training, and apprentice-level courses, and their expertise will not generally be available to the personnel developing and modifying the thousands of other Navy courses. Wider dispersion of training and other means of assisting development of these courses would be needed. There are some serious limitations in giving training in instructional technology as a solution to this problem. Since the knowledge base for the ISD procedures is incomplete, training for ISD practitioners would be difficult to specify and develop. It would probably have to be broad in scope and lengthy--probably equivalent to a graduate program in educational technology--and would have to be offered on a continuing basis because of personnel turnover. The impracticality and expense of such a program is obvious. Naturally, under any conditions, some in-service training will have to be offered on a continuing basis, and systematic evaluation of people's performance is necessary to assess their skill and to maintain their competency. Such training and evaluation, however, will not be sufficient to compensate for ISD inadequacies.

Another alternative is for the Navy to abandon the curriculum development business completely and contract for the development of training programs. This approach has serious limitations since potential contractors (1) have no better procedures for course design than the Navy does, (2) are not sufficiently familiar with Navy operational and training situations to develop courses that fully meet Navy requirements, (3) may not exist in sufficient numbers to handle the course development requirements, and (4) may cause implementation problems resulting from the "hand-off" process from contractor to Navy personnel.

The policy alternative that seems most appropriate is to retain current ISD methodology in its general form, but to actively support a program of research and development aimed at refining it, augmenting it where necessary, and improving its implementation and management. The need for systematic refinement of ISD methods and their implementation has already been recognized. The Chief of Naval Education and Training and NAVPERSRANDCEN have agreed to identify and seek R&D solutions to problems that impede successful implementation of the ISD process.[4]

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[4]Memorandum of Agreement between NAVPERSRANDCEN and CNET on research requirements, implementing R&D, and establishing the Experimental Training Programs Policy Board, ser 284, 13 May 1975.

Improving ISD Through Research and Development

The main deficiency of ISD procedures discussed so far is their failure to allow relatively inexperienced personnel to develop reliably good instruction (Hodak, Middleton, & Rankin, 1979; Miller, Swink, & McKenzie, 1978). This section describes some research and development efforts designed to refine and augment the ISD methodology through (1) conducting R&D aimed at acquiring the knowledge base necessary to develop more usable and manageable ISD techniques, (2) improving the current process by developing procedures to fill ISD gaps (e.g., quality control techniques and test development methodologies), and (3) improving the implementation and management of ISD by capitalizing on computer technology.

The Instructional Quality Inventory (IQI)

After examining the ISD process, it was recognized that, at several points in the developmental sequence, intermediate products (e.g., objectives, test items, segments of instruction, etc.) were available, but there was no check on their quality. This is particularly unfortunate, since later steps in the ISD sequence depend on the quality of these products. Therefore, the development of techniques for quality assurance during ISD was undertaken. First, the research literature was examined to determine what the tested or valid principles for prescribing instruction were. Then, techniques were devised to allow an evaluator to examine instruction and determine whether or not it conformed to those prescriptions. In brief, the evaluator makes sure that (1) the stated objectives are job-relevant, (2) test items are adequate for the purpose of assessing learning and are congruent with the objectives, and (3) course content is matched appropriately to the objectives and thereby to the job requirements. This technique is called the Instructional Quality Inventory (IQI).

A preliminary version of the IQI was developed by Professor M. D. Merrill and associates under contract to NAVPERSRANDCEN (Merrill & Boutwell, 1973; Merrill & Wood, 1974; Merrill, Richards, Schmidt, & Wood, 1977). The IQI then underwent extensive testing and revision in Navy courses to ensure that the procedures were clear and could be used by those who would be doing instructional development. User manuals, training materials, and job-aids were published (Wulfeck, Ellis, Richards, Merrill, & Wood, 1978; Ellis, Wulfeck, & Fredericks, 1979; Ellis & Wulfeck, 1978). The Chief of Naval Education and Training has since recommended their use throughout the NAVEDTRACOM.[5,6]

In helping make instructional materials and tests consistent with learning objectives, the IQI fills important gaps in ISD procedures that were revealed in surveys of instructional development personnel and of ISD implementation (Vineberg & Joyner, 1980; Hodak et al, 1979; Middleton et al, 1979). Until now, no systematic means existed for determining whether existing instruction is adequate for current purposes, thereby avoiding unnecessary development costs. ISD did require that existing instruction be reviewed but provided no guidance for this. As a result, this step received little attention in the development of new courses (Vineberg & Joyner, 1980). The IQI procedure can also be used to examine the quality of contractor-developed instruction.

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[5]Chief of Naval Education and Training, CNETNOTE 1550 of 6 April 1979; subj: Instructional Quality Inventory (IQI).

[6]Chief of Naval Education and Training, CNETINST 1550.15 of 29 May 1980; subj: Instructional Program Development Centers (IPDCs); policy and guidance for.

Guidelines for Criterion-referenced Testing

One of the goals of ISD is to make training relevant to job-performance requirements. Such performance-based training requires techniques for testing different from those familiar to most people. The tests commonly encountered are those that are used to compare a person's test performance with that of others. Examples of such tests are those used to select people for admission to training, advancement-in-rate, or college entrance, or to rank people relative to some group as in IQ tests, Civil Service professional administration career examinations, and the Armed Forces Qualification Test. These tests are called "norm-referenced," meaning that an individual's test performance is compared--referenced--to the average or "norm" of everyone else's test scores. Normative tests are, at best, only indirectly related to people's jobs. In contrast, performance-based training requires tests that directly measure aspects of performance required in course objectives. Tests of this type are called "criterion-referenced," meaning that an individual's test performance is compared--referenced--to an absolute objective or criterion indicating what a person must know or be able to do. Quite different problems are confronted in developing and using these tests in contrast to norm-referenced tests.

In addition to determining that an individual can do or does know whatever is specified in the objectives, it is necessary to be able to determine why a trainee cannot perform well so that the problem or errors can be corrected. Whenever remedies are prescribed on the basis of test results, diagnostic tests are needed. Diagnostic tests must be designed to give further information about gaps in student knowledge or skill, just as a physician uses additional diagnostic tests when symptoms indicate a medical problem. For example, consider a situation in which a student does not understand some instruction he has just read concerning when to use a particular procedure. When tested regarding when to use it, he makes an error. Since this is the only information the instructor has, the cause of the error is unknown. Usually, the student is given the same material to reread. If the misunderstanding is due to the fact that the explanation is unclear to the student, many rereadings of the instruction will not correct the error. Techniques for identifying why students make such errors are diagnostic. Once the misunderstanding is diagnosed, it can be corrected quickly.

Although both criterion-referenced and diagnostic tests are needed in ISD, guidelines are incomplete for developing the former and nonexistent for developing the latter. Therefore, improved procedures for test development in ISD are being developed. The resulting "handbook" will compile procedures from diverse sources (Merrill & Wood, 1974; Swezey & Pearlstein, 1974; Roid & Haladyna, 1979; Frederickson, Smith, & Pearlstein, 1979) and arrange them as "job-aids" for Navy test developers. The handbook is currently being refined during training workshops for Navy personnel and a final version will be provided to NAVEDTRACOM in FY 1982. The handbook will provide better guidance for test development throughout the NAVEDTRACOM. It will provide more complete and more usable procedures than now exist.

Computer-assisted Training Development

The earlier description of the ISD process gave no indication of record-keeping requirements, although formidable record-keeping problems exist. A typical Navy training program has hundreds or sometimes even thousands of learning objectives that must be developed, cross-referenced, tested, and taught. For example, about 7,000 learning objectives are contained in the training for P-3 aircraft crews (Daubek, Freedman, Walker, & Thode, in press).

Records also cover a wide variety of other ISD activities such as generating test items, choosing alternative training media and strategies, evaluating graduates, and revising courses.

Computerized data management systems not only can assist with these record-keeping problems but also facilitate the development process itself by providing guidance for test and instructional development and similar tasks. Moreover, computer-based systems can ensure that guidance is followed by monitoring and evaluating developers' performance and by assisting them as they proceed. Computer systems can also provide training for instructional developers, who can fit it into their work schedules.

NAVPERSRANDCEN is now developing computer-based aids for instructional design and development and will evaluate their usefulness. The first phase will help designers at critical points in the ISD process by guiding and monitoring each step involved in using the IQI and developing tests. Then programs will be expanded gradually to provide specific guidance on accomplishing each task, allow access to relevant data bases (e.g., test-item files, classifications of objectives, etc.), and help select alternative forms of instruction. These aids will include computerized ISD data management.

Some computer-based aids will be adapted from those being developed by other agencies. For example, the Army Research Institute is developing aids to help authors write, edit, and produce training materials (Schultz, Hibbits, Wagner, & Seidel, 1979). The intent is to make the production of materials simpler, faster, and less costly. Another system developed by the Navy Training Analysis and Evaluation Group (TAEG) (Braby, 1979; Braby, Parrish, Guitard, & Aagard, 1978) can be used by authors who are subject-matter specialists to write, edit, and produce programmed training materials. The authors use a terminal that is connected to an editing and production system. An executive program requests information about materials and test items that the author provides by typing on a keyboard. The system then arranges the material in a particular format and produces a programmed text. Time required for authoring and producing materials is reduced and, more important, requirements for instructional design expertise are reduced. Such devices enable personnel with only modest experience in instruction to develop quality instructional materials.

TAEG has also developed a computer readability and editing system (CRES), which is designed to improve the ease of comprehending Navy technical manuals and training materials. The system has features to detect uncommon and misspelled words and long sentences, suggest simple replacements for difficult words, and calculate the readability grade level. Each feature is consistent with Navy specifications and has been tested to verify that it provides useful feedback to editors and authors (Kincaid, Aagard, & O'Hara, 1980). CRES has recently been extended to incorporate some of the IQI criteria, so that it assists authors in building better tests in technical training (Kincaid, Braby, & Wulfeck, 1981). All of these systems are prototypes of more advanced ones that will design as well as produce instructional materials.

The systems described so far are intended mainly to support development of conventional training materials. However, as most people are aware, there is a current revolution in computer technology for training delivery. Computers are getting smaller, more powerful, and much less expensive. There is also a revolution in the areas of artificial intelligence and cognitive science that is less visible but perhaps more exciting. New techniques are being developed for giving computers real knowledge, for interacting with students in a more tutorial fashion, and for improving the interface between the student and the instructional device. These developments have the potential for making training better, cheaper, more manageable, and more widely distributed.

As attractive as these developments are, it cannot be assumed that they will immediately revolutionize training. Currently, the ISD manuals contain no information concerning computer-based instructional delivery. Yet, if such devices are to be widely used, methods for designing and developing instructional software must be institutionalized. The introduction of computers into the ISD process complicates it, because additional attention must be given during the analysis and development phases to instructional logic (which the instructor normally does), planning the student-computer interaction and interface, the types of student response data required, the schoolhouse utilization and maintainability of the hardware and software, and a variety of other issues. Computer-based author aids, then, must be developed to support ISD for new types of instructional delivery.

CONCLUSIONS

The ISD process is a synthesis of the results of nearly 40 years of research on instructional development and over 100 previous publications concerning what to do in instructional development. The review found widespread agreement that the ISD process is a good description of what has to be done in the process of analyzing, designing, developing, and managing instruction.

The ISD methods were originally developed to remind instructional development experts about steps needed to be accomplished to produce quality instruction. Recently, though, the intent of ISD methods has shifted. ISD manuals are now intended to help content specialists (who are relatively inexperienced in instructional design and development) build instruction. However, ISD methods do not achieve this intent, because, while they contain "what to do" information, they do not provide information on "how to do it."

This lack of detailed procedural guidance leads to two difficulties in implementing ISD: instructional engineering problems and management problems. Studies have revealed that ISD methods are not implemented well by the untrained, inexperienced personnel available. This leads, in turn, to problems in managing their ISD activity. These problems result in the development of instruction imperfectly matched to Navy jobs and increased costs for evaluation and revision of initially poor instruction.

A number of policy or management changes to alleviate these problems were considered, including (1) substitution of some other training development methods in place of ISD, (2) substantial training for ISD practitioners to compensate for ISD inadequacies, and (3) contracting for the development of Navy training programs. All these alternatives were rejected as being impractical, too expensive, or as simply cosmetic. Instead, it was decided that the best policy to follow is to improve the ISD methods and their implementation through a systematic research and development program. Several recent R&D efforts were summarized, including the IQI, which provides quality assurance methods for the ISD, the development of procedures for building more instructionally relevant tests in technical training, and the initial development of computer-based systems to assist in managing and conducting ISD. Computer-based aids to ISD, in particular, provide the best hope of improving the efficiency and effectiveness of the ISD process, and are essential as more training is delivered via computers.

RECOMMENDATIONS

1. This review identified some deficiencies in the ISD process and its implementation. However, these deficiencies were obtained from only a few studies of ISD and from relatively informal observation. It is essential that NAVEDTRACOM develop systematic methods for monitoring the implementation of ISD, so that problems can be identified. These problems should then be reviewed periodically to determine their amenability to management, personnel training, or R&D solutions.

2. NAVEDTRACOM should develop a system for monitoring the performance of ISD practitioners and managers and a systematic training and professional development program to improve their performance.

3. NAVEDTRACOM should actively support the development of automated aids to ISD and should begin planning and programming resources for their eventual implementation and operation.

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